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ABSTRACT

The Learning in Science Project identified the learner as the key perspective for in-depth study into problems and difficulties in the teaching and learning of science at the 10- to 14-year-old level. Two complementary research foci were established to explore this viewpoint: (1) interviewing children using strategies designed to establish various meanings held for words used in science and to identify children's views of various phenomena and (2) observing typical science lessons in an attempt to better understand the nature of children's classroom experiences. This paper is particularly concerned with methodologies used to observe children at work in their science classrooms and to handle data collected from these observations. Strategies used include case studies of specific lessons (the single lesson portrayal) and classroom issues in typical science lessons. Unobtrusive observation was employed to record action, dialogue, and comments from students, teachers, and observers of four aspects of the single lesson (nature of lesson set, set task, and students' actions/thinkings). Observational mechanisms for classroom issues included developing a comprehensive strategy for obtaining/analyzing information on the activities/perceptions of a single observer and applying "grounded theory" strategies to the many lesson-records obtained. (A framework for analyzing lesson-records and selected extracts from observations illustrating the research methodology are included in appendices.) (JN)

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LEARNING IN SCIENCE PROJECT

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PORTRAYING CHILDREN'S CLASSROOM EXPERIENCES

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WORKING PAPER 42

Introduction

Any research programme which sets out to enhance teaching and learning in a formal educational setting (often a classroom) faces the challenge of providing outcomes which have meaning to, and meet the needs of, the practioners involved (mostly teachers). Failure to make an appropriate response to this challenge is the 'Achilles heel' of much classroom research. As Barker (1968) and Willems and Raush (1969) argue, the quest for quantification and the desire to fit an empirical frame on a complex focus have often submerged the significance of the influence of the setting on the way teachers and pupils behave. According to Kemmis (1977) it has also frequently led to insufficient consideration by researchers as to the appropriateness of empirically presented findings for what is often a technically naive audience.

In response to these perceived short falls a number of workers, perhaps most notably, Parlett and Hamilton (1977) and Stake (1974) have established a focus for classroom research where the emphasis is on what is going on in the educational setting and where the needs of the audience are given prominence. This shift in focus has enabled naturalistic strategies to be applied to both data collection, for example participant observation in its various forms (Smith, 1978), and data organisation, for example case study (Stake, 1967) and grounded theory (Glaser and Strauss, 1967). A further important aspect of this paradigm shift as Nisbet (1978) suggests, has been to recognise the viewpoint of the learner as critical in understanding the education process.

The pattern of research development described above is emerging in some aspects of science education enquiry. An early call for an alternative research focus in this particular field was made by Hurd (1971) who suggested science education research should be less method-centred and more people-centred. This view has been echoed by Kempa (1976) who noted that two of the criticisms levied against science education research in the past has been the tendency of research in science education to work only within the psychometric paradigm and to pay inadequate attention to the learner who, after all, is at the centre of the education process. More recently Kornhauser (1979) has stated

"the relatively limited success of these (psychometric) research approaches has led to new forms of data collection. Among these, participant observer research is now prominent. A number of authors (Penick et al, 1976) report on data collection by teams of observers in the classroom. However difficult this approach may still be, it represents a positive trend in research in science education".

The Learning in Science Project (see Tasker et al, 1980) has identified the learner as the key perspective for in depth study into problems and difficulties in the teaching and learning of science at the 10-14 year old level. Two complimentary research foci have been established to explore this viewpoint. One focus has involved interviewing children using strategies designed to establish the various meanings held for words used in science (Osborne and Gilbert, 1980a) and to identify children's views of various phenomena (Osborne, 1980). This work has run parallel with the second focus which has involved observation of typical science lessons in an attempt to better understand the nature of children's classroom experiences. The two foci support each other in that the interview work has sensitized us to pupil's views while the classroom observations have helped identify aspects of "children's science" (Osborne, 1980) which have been further explored by structured interviews (e.g. Osborne and Gilbert, 1980b). In all of this work our concern has been to provide insights into the world of the science learner and in so doing provide an alternative perspective of the science classroom to that currently held by teachers and others.

This paper is particularly concerned with the methodologies we have employed to observe children at work in science classrooms and handle the data collected from these observations. These methodologies have been influenced by our desire to confront the issues raised in the above discussion. We have exploited the power of participant observation (Smith, 1971, and Wilson and Archer, 1979) to avoid the artifacts which emerge in research settings (Wilson, 1977), and have attempted to develop data-handling strategies which allows a descriptive representation of the learner's perspective.

The audience

With respect to classroom research, Kemmis(1977) suggests two situations where representations which seek to 'tell it as it is' are likely to be particularly useful. The first is where the audience is so involved in the functioning of the programme that they are unable to step back and view it from other perspectives. The second is where an interested audience is too distant from the programme to feel comfortable about making decisions relating to it.

In addition to our own research interests, we entered classrooms to provide information for these two audiences. We wanted to provide those teachers with whom we have worked with feedback on their own science programmes; many of whom, it seemed to us, in the absence of such feedback have insufficient information upon which to self-diagnose the strengths and weaknesses in the practices they employ. For some teachers this is a lonely and discouraging position.

> "I have no feedback ..... I have no idea of my success or failure... I have no idea of how I am succeeding and I think this is a shame."
>
> (experienced classroom teacher)

We also wanted to provide the 'distant' audience - teachers in other schools, curriculum developers, textbook writers, teacher trainers and teacher trainees - with information from the classroom, based on the learner's perspective, which may be useful to them in teaching, preparing curriculum materials and planning teaching strategies.

Both of these audiences have an interest in the range of views brought by learners to the science classroom and in the scope of learner responses to the various activities found there. However, as mentioned above, teachers also have an interest in the immediate and particular responses of their own pupils to the science opportunities they provide in any lesson. In response to these different needs we have developed two research strategies each aimed at allowing the learner's view of the science classroom to be portrayed. These are;

(i) Case Studies of Specific Lessons. These have been developed using a strategy which has two or more observers in the classroom at the same time. Inside the classroom each observer operates independently to collect a record of the lesson.

(ii) Classroom issues in typical science lessons. These have been identified by a programme of observations by a single observer inside a wide range of science classroom.

In the following we first discuss the observational mechanisms we employ, as these have many common features for both strategies. As the observational foci of the lesson are inherently bound up with the research strategies themselves we will postpone discussion of this aspect of the observational work until the next section.

Observational Mechanisms

As indicated above we have been concerned to preserve the natural setting. This has been attempted by establishing a colleague relationship with the teachers whose classrooms we have visited and by being as unobtrusive in our observations as is possible[1]. Once in the classroom we learn about classroom perspectives by hearing the teacher and pupils express themselves in the flow of classroom events and by asking the participants questions thereby becoming acquainted with viewpoints that are rarely expressed. We obtain a record of these perspectives by carrying a small audio-recorder. We make few written notes even though, in this regard, the science classroom may offer an advantage since in many lessons pupils make frequent records of measurements from experimental investigation. As indicated we ask questions of participants. Such questioning is carefully restricted - experience has shown that too early an intervention can influence a pupil's subsequent behaviour. Furthermore, questions are carefully framed to elicit the views of pupils (for example see Appendix A) as opposed to standard classroom questions which typically seek to establish whether or not pupils hold particular views.

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1 A checklist of procedures we have adopted to establish contact with the classroom teacher and to collect data inside working classrooms is available from the authors.

The most difficult perspective to tap, in our experience, is that of the teacher: teachers are so busy both before and after any lesson and we avoid interaction with them during lessons. Of course there are 'public' clues regarding this perspective - teacher talk, teacher organised visual aids as well as worksheet and text material all provide information. However, the view this all gives can sometimes be misleading since, we have found the real teacher perspective can be kept 'private', only becoming apparent with supplimentary questioning. In spite of this problem of access, every effort is made to establish the teacher's perspective since this view of the various parameters of the lesson provides an important framework against which the views of the learner can be placed. Fortunately, teachers have been both frank and open in our discussions with them.

Both sets of data are initially subjected to the same treatment. The audio-records taken from the classroom(s) are first transcribed and the transcript produced then annotated using observations noted as well as details from the written material used during the lesson.

Research Strategies

The single lesson portrayal is achieved first by the two observers in the classroom actively seeking a record of action, dialogue, and comment which contain the various perceptions (pupils, teacher and observer) of four aspects of the lesson (the nature of the set of lessons, the set task, pupils' actions, and pupils' thinking). The two lesson-records are then set alongside one another and comparisons drawn. Our experience has been that the two records both compliment and suppliment but rarely conflict, similar issues being identified in both records. The two records tend to suppliment each other in the depth of perceptions achieved on the various identified issues: one observer will have pursued more vigorously or obtained more perceptive comment on one group of issues while the other observer will have explored more deeply another group of issues. A single portrayal is then made using the two lesson-records. The structure of the portrayal reflects the four aspects of the lesson, which provided the broad framework for the investigation, namely

* the nature of the set of lessons ("the way we are taught")
* the set task ("What we have to do today")
* the pupil's actions ("The way we cope with the task")
* the pupil's thinking ("What we understand about what we are doing")

Once written the portrayal is made available to the classroom teacher for consideration and comment. Further release of the document to a wider audience is only undertaken if the teacher is perfectly agreeable that this should be so. Two working papers of the Learning in Science Project A visit to a classroom and Another visit to a classroom provide two currently available examples of such portrayals. In Appendix B extracts from the second of these two papers exemplify this work.

Classroom issues have been developed by one of us (R. Tasker)

(i) by developing a comprehensive strategy for obtaining and initially analysing information on the multitude of activities and perceptions which face a single observer collecting data in a classroom.
(ii) by applying "grounded theory" strategies (Glaser and Strauss, 1967) to the many lesson-records that have been obtained. The use of grounded theory in research into New Zealand classrooms has been advocated by Battersby (1979).

The development of the investigatory strategies, for obtaining and initially analysing the data, has proceeded alongside the development of the associated framework for research action (Figure 1).

To appreciate aspects of this framework let us consider data analysis. Initially the record of the lesson is categorised according to the actions and dialogue of pupils and teachers. These allow the researcher to make inferences relating to the various perceptions involved. In the classroom similar inferences have led the researcher (in his capacity of participant observer) to explore through question and

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1 Typical headings used in a portrayal to emphasise that the portrayal is concerned with the learner's perspective. We consider this type of heading is also more appropriate for our audiences.

comment these underlying perceptions in some depth. The result of this is, that the record also contains comment from pupils and the teacher which reflects their perceptions of events and phenomena associated with the task and these are also categorised and likewise considered by the researcher. Thus a second level of inference can be made in the analysis (see Figure 1) sometimes it has been useful to return to the same classroom to explore further certain aspects of pupil and teacher thinking. Whatever, the practice of analysis keeping step with data collection enables the researcher to take an ever expanding appreciation of classroom issues into the next lesson he visits.

The sequence of action and dialogue provided in Appendix C illustrates the nature of the data collected in this aspect of our work and how the data is organised. Some of the major issues and problems of science teaching and learning in the classroom identified by this approach are detailed by Tasker (1980).

Discussion

The response of teachers to the portrayals of single lessons can be considered in terms of the two audiences identified by Kemmis(1977). In terms of the intimate audience - those teachers whose classrooms lessons we have portrayed - we have found every teacher supportive of what we are attempting, and interested to learn about their classroom through the portrayals. Without exception they have accepted our portrayal as valid yet consider it provides them with insights which they find useful. For example,

> "The most illuminating thing (in the portrayal) is the series of observations about the assumptions I made - and the kids themselves made about their background skills - in this case using an atlas. I am currently using the core of an electricity unit and have just dimly perceived the same problem with putting circuits together from circuit diagrams. Your paper has crystallised the problem nicely."
>
> (an extract from a classroom teacher's response to a portrayal of his classroom)

In terms of the distant audience, we have found teachers in other schools who have read the portrayals with interest, who have identified with situations similar to their own, and who have even modified their

own teaching in the light of reading a portrayal about someone else's classroom.

> "I found the paper very interesting - I identified with the situations in it and appreciated the things it was saying. It made me think about my own lessons and since reading it I've made some changes ... I've tried to get over the problem of kids losing sight of what the work is all about by having quite specific objectives and checking the kids about these each period ... and as well by reviewing these objectives at the beginning of each period."
>
> (secondary teacher commenting on 'A visit to a classroom')

As part of the final phase of the Learning in Science Project (Tasker et al, 1980) we intend to develop a collection of portrayals to display the perspective of the learner in a range of situations, i.e. situations differing in teaching approach, topic involved and outcomes achieved; these hopefully will provide teachers with a series of alternative frameworks against which to consider their own classroom lessons and perceptions.

The grounded theory approach is, by its very nature, a much longer term process than is the single lesson - case study strategy. However the issues that have already emerged (Tasker, 1980) we consider are important and central issues. In continuing to pursue this avenue of analysis we have been encouraged by the comments of Kornhauser (1979) which support systematic observer research as "likely to lead to valuable results, especially if they derive from long term studies".

We believe the two methodologies we have employed to provide information about children at work in science classroom could be of benefit both in curriculum development and in teacher training. We have found the issues raised by our work, when exemplified with extracts from portrayals, leads to lively discussions about teaching and learning amongst groups of teachers, science advisers, teacher trainers and teacher trainees. This type of work could also be useful in formative evaluation of draft science curricula materials and innovative teaching strategies. Currently such evaluation is primarily based on teachers perspectives and our work clearly indicates to us that the teachers' stated perspectives are frequently different from the learners' perspectives. We would contend that a more meaningful evaluation would be possible if the learners' perspective, and the teachers' comments on

that portrayed perspective, were also available. In our experience, such teacher comment not only ensures moderation of the portrayal but evokes more realistic perspectives from those teachers.

Finally, we would wish to stress the importance of this type of research in closing the gap between teacher and researcher. Although we have authored this paper it should also really carry the names of those with whom we have worked. We highly value their professional contribution to our mutual long term goal of improving the teaching and learning in science classroom.

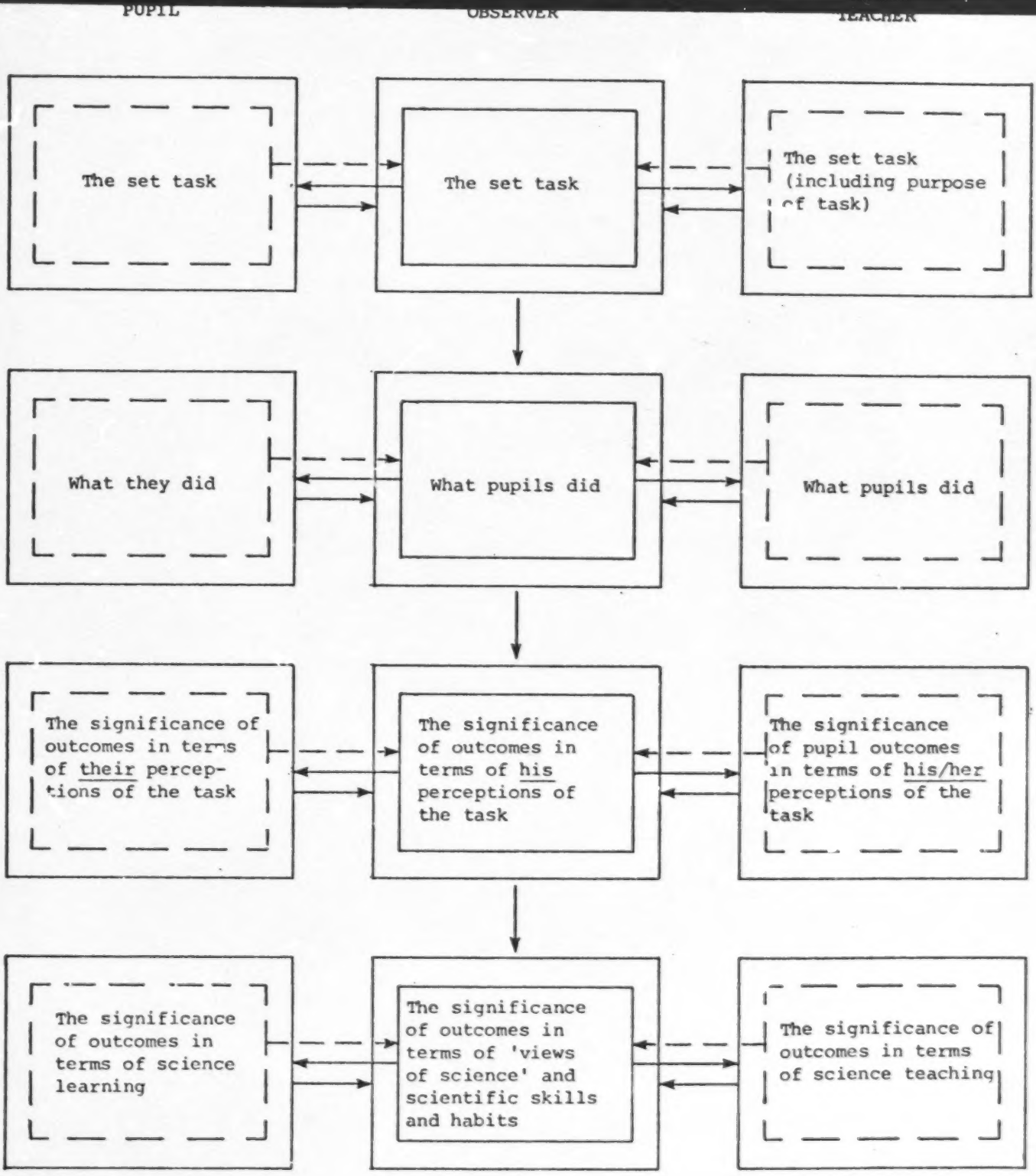
PUPIL
OBSERVER
TEACHER
The set task
The set task
The set task (including purpose of task)
What they did
What pupils did
What pupils did
The significance of outcomes in terms of their perceptions of the task
The significance of outcomes in terms of his perceptions of the task
The significance of pupil outcomes in terms of his/her perceptions of the task
The significance of outcomes in terms of science learning
The significance of outcomes in terms of 'views of science' and scientific skills and habits
The significance of outcomes in terms of science teaching
Teacher and pupils' action and dialogue.
Pupil's, teacher and observer's perceptions of aspects of the lesson.

FIGURE 1: A framework for analysing lesson records

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Appendix A. An example of exploring the learner's perspective with minimal observer interaction.

Following pupil involvement with an investigative task involving dissolving crystals of potassium permanganate in hot, and in cold, water a group of four 4th formers answer a worksheet. Their answers are superficially those of the scientist. The two questions, the responses made, together with insights into the thinking behind these responses are given below.

P_3 (reading question one) "I think particles in water can or cannot move about? .....can!" (Writes 'can' in worksheet)

P_1 "What particles in water can move about?"

P_4 "..... crystals, probably the crystals."

P_3 "Yeah, they probably mean the crystals."

P_1 (reading question two) "These particles move easily/not so easily if the water is hot ..... they move easier ..... the particles can move a lot easier." (Crosses out 'not so easily' in worksheet)

O .... "what particles?"

P_1 "The crystals."

P_3 "The crystals can move a lot easier."

O "The crystal you dropped in?"

P_1 "Yeah"

O "Is that the particle the question is talking about?"

P "Yeah" (Group chorus)

O "Are there any other particles?"

P_1 "No"

P_4 "Not in that one."

Appendix B Extracts from Another visit to a classroom

The following are extracts from a portrayal of a 4th form science class. The portrayal considers four levels of the learners' perspective, and extracts are provided from each level.

(i) The way we are taught.

"Cores" and "loops" are two words frequently used by pupils in this class when they talk about the way they are taught. The following is a typical conversation we had with a student in the class on this topic.

O "Can you tell me about this core section work?"

P "We have a certain amount of work that everyone does ... say about 12 periods."

O "Now when you work on the core you are all normally working on the same thing."

P "Yes, everyone does the core. Usually (we work) all together in the core ... this is the first one (in 13 months) we have done at our own rate."

O "Right, then after that you do loops or something?"

P "Yes loops ... that's ... we have a mastery test and the things you don't understand you get given to you on a printed sheet and you work things out on your own and you do your own research."

O "What happens if you get the mastery test all correct to start with?"

P "Then you will get things he (the teacher) thinks you need to work on .... where you get a choice."

O "When you work individually do you work by yourself or in pairs?"

P "Oh working by yourself usually."

This method of operation, normally involving at first a common core which is teacher-dominated followed by varied pupil-paced work dependent on the abilities and interests of the pupils, seems to be enjoyed by all we talked to.

P "It's a lot better eh? I know, a lot more people ... like if you go around here (this class) most people will say that it is a lot better ... about the whole class likes it this way

because then you don't have to come in and sit down and listen to a teacher talking all day and then just copying notes. You know you can get that way ... you know in Form II before I came here ... that's all we used to do you know at intermediate ... it's boring. This is better, a lot better and you learn more, too ... you are on your own and not teaching (being taught at) cos when you are with teachers a lot of people just sit there and say nothing ... but when you work like this he checks your work and sees how you are going on ... It makes everyone work and then it gets easier."

(ii) What we have to do today

T "See the basic idea (of the task) is to get you to locate a series of features of the planet ... there are mountains ranges, ocean trenches, ocean ridges, some localities where over the last 20 years there have been some pretty bad earthquakes, and over the page a list of 40 volcanoes."

T "How many people have not used an atlas before? (only positive responses given) so everybody can actually use an atlas? (chorus of yeses and few noes). Get into it!"

Further instructions as considered necessary were given in the next 15 minutes or so as people worked. By then, everyone was busy on the task, using the atlas. The impression gained was that the instructions were clear, all pupils' questions had been answered, pupils knew what to do and were proceeding to do it.

(iii) The way we cope with the task

O "How did you find all these (features)?"

P "Some of them I looked up the back at the index and the others I just looked at the countries."

O "What did you do first, look in the index or at ...?"

P "At the pages."

O "Is that quicker or what?"

P "Yeah that's quicker - a lot quicker than using the index."

O "What's hard about using the index?"

P "I can't understand the North and the West."

O "Don't you know what to do when you see the numbers?"

P "Sometimes I do - sometimes not."

O "Sometimes not."

P "I get confused which way is East and which way is West."

O "Quite hard is it?"

P "Yes."

Others gave up using the detailed information in the index entirely.

P "I look in the index and look at the page number."

P "I looked at pl4 and 15 Map of the World and looked around for things."

(iv) <u>What we understood about what we are doing today</u>

O "What has the teacher go you to do this for? (no response) What has mountain ranges got to do with earthquakes? Anything?"

P "No we are just studying the earth's crust and that and the things that are on it."

O "I notice that this thing (task sheet) has got earthquakes, ocean ridges, ocean trenches, mountain ranges and volcanoes. Is there any connection between any of these things, do you think?"

P "Yes, I think it is to do with movement of rocks and energy and that."

O "What about the ocean trenches, have you found them?"

P "Yeah."

O "What are they really?"

P "I don't know - they are just the stupid stuff in there."

O "What does it mean 'ocean trench'?"

P "To me boundaries of an ocean, I think."

O "Boundaries of an ocean."

P "Or something anyway - I don't understand it, nah."

O "You don't understand it - in what way?"

P "I don't really know what the ridges are either - hang on I think the ridges are where the ocean is - the main areas of the ocean."

O "The main areas."

P "It might mean 'end'."

O "End of the ocean."

P "Yeah."

O "Where would you draw them?"

P "Right around the edges (tracing path around edges of Pacific)."

Appendix C Extracts from a classroom analysis

The following extracts have been taken from the lesson-record of a 4th form mixed ability class considering the topic "the effect of heat energy on dissolving". The significant outcomes for the teacher were to develop ideas about the particle nature of matter.

Teacher action and comment relating to the set task

"Fill your beakers up with hot and cold water and very important - allow the water to become still ..... then what you are going to do is drop bits of potassium permangamate - they are only little bits - so you are going to have to use tweezers to get them from this dish up the front (holds up metal dish briefly then returns to front bench). Add one to the hot water and one to the cold then it (instructions in pupil worksheet) says 'results - what to write in your book' - what happens to the Condy's in the beaker? ....."

Pupil action and comment relating to what they did

P_1 "I'll put one in the hot water (holding crystal above 'hot' beaker)."

P_2 "Not yet ..... It's (the water) got to settle before it goes in."

P_1 (waits briefly) "I'll put one in the cold water ..... OK ? (Shifting crystal to above 'cold' beaker)."

P_4 "It's not settled yet."

P_3 "Is that (indicates 'hot' beaker) settled now?"

P_4 "No, not properly."

P_3 "The cold one's just about. Try the cold one now."

P_2 "The hot one."

P_4 "You can still see the things (water currents) going around."

P_2 "Put one in here (the 'cold beaker', P_1 drops in a crystal). Put another one in here (in the 'hot' beaker, P_1 drops in a crystal)."

P_4 "No ..... not yet (but it is too late) ..... You shouldn't have done that - we should have done it one at a time."

Pupil action and comment relating to the significance of outcomes in terms of their perceptions of the task.

P_2 "What's it doing (indicating the 'hot' beaker).

P_1 "It's spreading".

P_2 "It's starting to spread very slowly".

P_1 "No ..... look at this (the 'cold' beaker)".

P_2 "Well that's cold .... no wonder ..... as it went down it was a big blob (the crystal) then it started to spread - you can still see the crystal (pointing to beaker) .... it seems to have stopped once it filled half of it".

Pupil perceptions relating to the significance of outcomes in terms of science learning

O "What's happening when the crystal dissolves?"

P_4 "dissolves and keeps going".

O "Is the crystal still there?"

P_2 "Yep".

P_1 "Yeah - just though".

O "Just though".

P_3 "Yeah - the colour's come out of it".

O "The colour has come out of it'.

P_3 "Yeah - dissolved out of it".

P_2 "Well, there won't just be a white crystal down there .... it's still purple".

P_1 "It won't all be purple".

As indicated in this example, and a second example is provided in Appendix A, the observer is able to probe pupils perceptions relating to actions and dialogue and in doing so confirm inferrences made while the pupils are interacting with the task.